

A Proto-Type for Home Automation Using GSM Technology

B. Srinivasa Rao, S.D.V. Prasad and R. Madan Mohan

Abstract-- In the present paper we have designed and implemented a typical and simple Home Automation System using GSM (Global System for Mobile Communication) technology that controls electrical devices at home from a remote location by a simple mobile phone. This is achieved by sending an SMS to receiver present at home which is in turn connected to a hardware kit. The SMS received by the receiver is transmitted to the microcontroller which reads the message and controls the appropriate device. This operation is performed by program written in assembly language code that is stored in the flash memory which is in-built into the microcontroller. The practical implementation of the present prototype has been successful to control some electrical devices using an embedded circuit via SMS.

Index Terms-- Embedded System, GSM, Home Automation, Mobile Communication and Remote Control.

I. INTRODUCTION

The concept of smart home is an emerging issue to the modern technology dependent society. Remote control technologies are widely used to control household electronic appliances without walking up to them. Controlling household appliances through computer can also be a possible solution. However, it cannot fulfil the current demand which is to control them from remote places. The advantages of cellular communications like GSM technology is a potential solution for such remote controlling activities. [1]. Home automation systems are a result of an attempt to enhance the standards of living around and inside the house and were made possible by the breakthrough in the area of integrated circuits and microprocessors.

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These systems provide the consumers with increased security and safety, economic benefit through energy control, and convenience by giving them control over every piece of domestic electrical equipment in the house [2]. Literature reveals that the main objective for using GSM(Global System for Mobile Communication) network for the communication between the home and the users(and vice versa) is its wide spread coverage which makes the whole system online for almost all the time[3]. Home security system is needed for occupants' convenience and safety. At the same time it is required design and implementation of a low cost, low power consumption, and GSM/GPRS (global system for mobile communication /general packet radio service) based wireless home security system. The system is a wireless home network which contains a GSM/GPRS gateway and three kinds of wireless security sensor nodes that are door security nodes, infrared security nodes and fire alarm nodes. The nodes are easy installing. The system can response rapidly to alarm incidents and has a friendly user interface including a LCD (liquid crystal display) and a capacitive sensor keyboard. The wireless communication protocol between the gateway and the nodes is also suitable for other home appliances. Furthermore, some more methods are taken to ensure the security of system information [4]. With state of the art technology it is possible to achieve home automation with remote control and monitoring via GSM phones with low cost, less power consumption and good performance [5]. In the present paper we have designed and developed a typical and simple Home Automation System using (HAS) GSM technology that control electrical devices at home from a remote location by a simple mobile phone.

II. GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM)

The Global System for Mobile Communications (GSM) is the most popular standard for mobile phones in the world. The key advantage of GSM systems has been higher digital voice quality and low cost alternatives to making calls such as text messaging. The advantage for network operators has been the ability to deploy equipment from different vendors because the open standard allows easy inter-operability. The architecture of the GSM network is briefly described below.

A GSM network is composed of several functional entities, whose functions and interfaces are specified.

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Figure 1 shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. The subscriber carries the Mobile Station. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile Services Switching Centre (MSC), performs the switching of calls between the mobile users, and between mobile and fixed. MSC also handles the mobility management operations. Not shown is the Operations and Maintenance Centre, which oversees the proper operation and setup of the network. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link. The Base Station Subsystem communicates with the Mobile services Switching Centre across the A interface. The architecture of GSM is shown in Fig.1

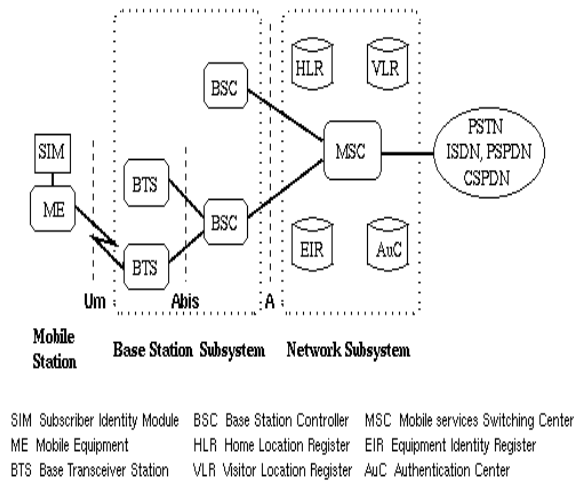


Fig.1. Architecture of GSM

III. HOME AUTOMATION USING THE GSM (PROTO-TYPE DESIGN)

The design of the Home Automation proto-type using GSM is shown in fig.2. and its implementation in the lab is shown in fig.3. The aim is to control electrical devices at home, from a remote location by a simple mobile phone. This is achieved by sending an SMS to a receiver present at home which is in turn connected to a hardware kit. The SMS then received by the receiver is transmitted to the microcontroller (present in the kit) using a serial port. The microcontroller then reads the message received and controls the appropriate device. To achieve this, Microcontroller (AT90S8515) is coded with a program (written in assembly language). This program is stored in the flash memory which is in-built into the microcontroller. The microcontroller also has I/O ports which are used to control the state of the output devices. The devices are connected to the microcontroller through relay circuits so that the mother board is protected from strong reverse currents in case high voltage appliances are used. The following components constitute the hardware kit used for home automation. A G.S.M. cell phone, A G.S.M. modem (transmitter/receiver), AT90S8515 microcontroller, Relay

Circuits, Reset Circuit, Power Circuit, Max 232 Chip, Serial port and a Serial Bus.

The Microcontroller AT90S8515: The AT90S8515 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the AT90S8515 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.

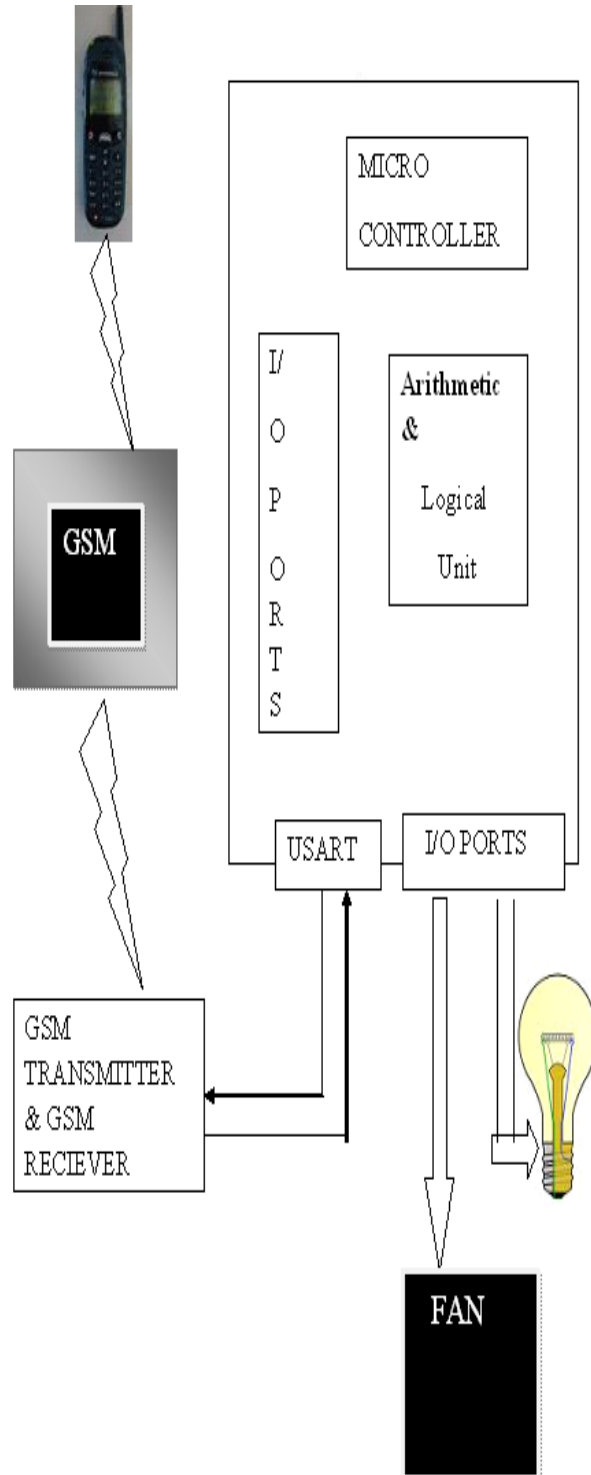


Fig. 2. Block diagram of home automation

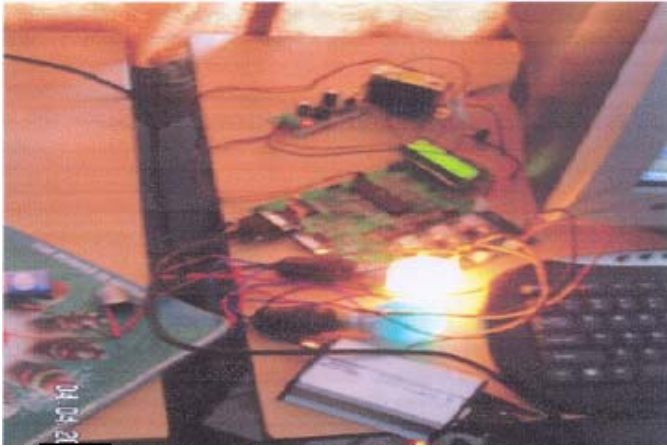


Fig. 3. Photograph of practical implementation of the proto-type

IV. CODING

The algorithm for Home Automation using G.S.M (Programming the Hardware Kit) is given below:

Step 1: The Pins of port c are defined as the I/O ports. As only 3 devices are being used in our case just the pins 0, 1, 2 are cleared.

Step 2: The USART is initialized to work in both transmission and reception modes. This is done by Moving \$86 in UCSRC and setting the baud rate at customary value of 12 (\$0C) and setting the bits TXEN and RXEN of UCSRB. Also baud rate is doubled for better performance. (By setting the bit U2X of UCSRA)

Step 3: The stack pointer is set to the end of SRAM locations, just in case it is required.

Step 4: The AT Commands are written into the flash memory which are to be retrieved later.

Step 5: The first AT command (AT+CMGF=1) is retrieved from flash memory and transmitted to the G.S.M. modem. This code enables the microcontroller to detect the G.S.M. modem.

Step 6: The Microcontroller Awaits for a confirmation code (OK) to proceed further. If an error code (OR) is received, Start over from Step 1

Step 7: The second AT command (AT+CNMI=2, 2, 0, 0, 0) is retrieved from flash memory and transmitted to the G.S.M. modem. This code enables the microcontroller to set the baud rate of the G.S.M. modem.

Step 8: The Microcontroller Awaits for a confirmation code (OK) to proceed further. If an error code (OR) is received, Start over from Step 1

Step 9: The third AT command (AT+CMGR=1) is retrieved from flash memory and transmitted to the G.S.M. modem. This code enables the microcontroller to continuously interact with the G.S.M. modem.

Step 10: Retrieve Data from the Modem.

Step 11: If a confirmation code (+CMT) is received by it (which signifies an sms received by the modem), the micro controller can receive the SMS from the Modem. Else go to Step 12: Read the next Byte of the message.

Step 13: If this byte is equal to \$13 (ASCII value of ENTER key) then proceed to next step Else go to Step 12.

Step 14: Initialize SRAM. i.e. set the X pair registers to \$0100 (which is an address Location in SRAM).

Step 15: Read the next byte from the SMS message and write it into next byte SRAM.

Step 16: Check if this byte is equal to \$13 (ASCII value of ENTER key)

Step 17: If it is equal go to Step 18 ELSE go to step 15

Step 18: The SRAM pointer (X pair register) is set back to its original value

Step 19: The first byte is stored in a register named dvc, which signifies the code of the device to be controlled.

Step 20: The second byte is stored in a register named status, which signifies whether the specified device is to be turned on (1) or off (0). And the SRAM pointer is reset again

Step 21: If dvc not equal to '1' (or ASCII \$31) Go to Step 25

Step 22: If Status equals '1' (or ASCII \$31) Set pin 0 of port C, go to Step 12.

Step 23: If Status equals '0' (or ASCII \$30) Clear pin 0 of port C, go to Step 12.

Step 24: Go to Step 10

Step 25: If dvc not equal to '2' (or ASCII \$32) Go to Step 29

Step 26: If Status equals '1' (or ASCII \$31) Set pin 1 of port C, go to Step 12

Step 27: If Status equals '0' (or ASCII \$30) Clear pin 1 of port C, go to Step 12

Step 28: Go to Step 10

Step 29: If dvc not equal to '3' (or ASCII \$33) Go to Step 33

Step 30: If Status equals '1' (or ASCII \$31) Set pin 2 of port C, go to Step 12

Step 31: If Status equals '0' (or ASCII \$30) Clear pin 2 of port C, go to Step 12

Step 32: Go to Step 10

Step 33: If dvc not equal to '4' (or ASCII \$34) Go to Step 10

Step 34: If Status equals '1' (or ASCII \$31) Set pins 0,1,2 of port C, go to Step 12

Step 35: If Status equals '0' (or ASCII \$30) Clear pins 0,1,2 of port C, go to Step 12

Step 36: Go to Step 10

Step 37: End process.

V. TESTING THE CODE

We have so far discussed the basic design and working of the proposed Home Automation System using GSM. But any project is not complete without exhaustive testing and debugging, and ours is not any different. The input here in our project, is the SMS that is received by the GSM modem (which was sent by a remote user using a cell phone). The SMS, that is received, is then stored in the SRAM via USART. This is done by the calling a sub-routine "read-msg". Assuming that the SMS sent has only two characters, the first one is stored in a register called 'dvc' and the second one in another register called 'status'. If the SMS sent has more than 2 bytes of data, then only the last two bytes are taken into

consideration while implementing the code. Now depending on the SMS sent, the microcontroller controls the appropriate device by reading the values present in dvc and status registers, if the dvc register is 1, the first device is controlled if the dvc register is 2, the second device is controlled if the dvc register is 3, the third device is controlled if the dvc register is 4, the all the devices are controlled Irrespective of the device, if the status register is 0, the device/devices is/are made to turn OFF. And turn on if the status register is 1.Hence in this way, an SMS that is sent, is stored in intermediate memory locations (registers) and in turn are used to control the actual devices. The practical implementation is shown in Fig.3. The table in the following page depicts the I/O States for various inputs that are given and a result that is achieved.

| Input Value (SMS Sent) | Intermediate Values | | Output Values | | |
|------------------------|-----------------------|--------------------------|---------------|----------|----------|
| | Device Register (dvc) | Status Register (status) | Device 1 | Device 2 | Device 3 |
| 10 | 1 | 0 | Off | NC | NC |
| 11 | 1 | 1 | On | NC | NC |
| 20 | 2 | 0 | NC | Off | NC |
| 21 | 2 | 1 | NC | On | NC |
| 30 | 3 | 0 | NC | NC | Off |
| 31 | 3 | 1 | NC | NC | On |
| 40 | 4 | 0 | Off | Off | Off |
| 41 | 4 | 1 | On | On | On |
| 00 | 0 | 0 | NC | NC | NC |
| 110 | 1 | 0 | Off | NC | NC |
| 011 | 1 | 1 | On | NC | NC |
| 1011 | 1 | 1 | On | NC | NC |
| 1110 | 1 | 0 | Off | NC | NC |

NOTE: NC indicates that the devices remain in the state that it existed in before the SMS was sent. i.e. NO CHANGE

VI. CONCLUSION

In the present work, we have operated the designed home automation system to control electrical devices using an embedded circuit located remotely, via an SMS. This however is only a prototype into the technology that has far reaching consequences.

Further extension of the work is to analyse the real time response of events based on speed aspect. Also more devices are to be included for control. Further the format for SMS record and its relevant fields are to be well defined. In future we would like to extend this work for more additional and minute control features of the home appliances by including the new evolving technologies. Integrating with newer technologies would enable us to have far greater improvements in control and automation technology than what we possess now.

VII. ACKNOWLEDGEMENTS

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